

INDUCTIVELY COUPLED METHOD AND APPARATUS OF
COMMUNICATING WITH WELLBORE EQUIPMENT

CROSS REFERENCE TO RELATED APPLICATION

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This is a divisional of U.S. Serial No. 09/859,944, filed May 17, 2001, which is a continuation-in-part of U.S. Serial No. 09/784,651, filed February 15, 2001, ^{now abandoned} which claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Application Serial No. 60/212,278, filed June 19, 2000, and which is a continuation-in-part of U.S. Serial No. 09/196,495, filed November 19, 1998. ^{now US 6,209,648}

BACKGROUND

The invention relates to an inductively coupled method and apparatus of communicating with wellbore equipment.

A major goal in the operation of a well is improved productivity of the well. The production of well fluids may be affected by various downhole conditions, such as the presence of water, pressure and temperature conditions, fluid flow rates, formation and fluid properties, and other conditions. Various monitoring devices may be placed downhole to measure or sense for these conditions. In addition, control devices, such as flow control devices, may be used to regulate or control the well. For example, flow control devices can regulate fluid flow into or out of a reservoir. The monitoring and control devices may be part of an intelligent completion system (ICS) or a permanent monitoring system (PMS), in which communications can occur between downhole devices and a well surface controller. The downhole devices that are part of such systems are placed in the well during the completion phase with the expectation that they will remain functional for a relatively long period of time (e.g., many years).

To retrieve information gathered by downhole monitoring devices and/or to control activation of downhole control devices, electrical power and signals may be communicated down electrical cables from the surface. However, in some locations of the well, it may be difficult to reliably connect electrical conductors to devices due to the presence of water and other well fluids. One such location is in a lateral branch of a